

Do *Materials Science and Engineering* students learn the workplace skills, attitudes and abilities that they need as graduates?

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Abstract

For most students in Higher Education, employment upon graduation is a major priority and there is currently a lot of emphasis being placed on providing students with the 'employability', or 'workplace' skills they will need after graduation. The UK Centre for Materials Education (UKCME) has undertaken a survey of graduate Materials engineers who have continued into a Materials-related career, and a parallel survey of Materials academic staff from all UK Higher Education Institutions (HEIs) teaching Materials Science and Engineering which focuses on the professional 'workplace skills, attitudes and abilities' that Materials students acquire during their academic studies, and whether they match the skills, attitudes and abilities that they require in the early stages of their professional careers. Graduates generally agreed with academics that they had been very well equipped for report writing, laboratory skills, and written communication, but had not found laboratory skills as relevant to their early career as academics had predicted. With the exception of 'Laboratory skills', the views of recent Materials graduates suggest that the provision of more training in each of the 'workplace skills, abilities and attitudes' would be of benefit to a graduate in the early stages of their professional careers.

Introduction and Methodology

The UK Centre for Materials Education (UKCME) has undertaken a major study to produce a *National Subject Profile (NSP) for Higher Education Programmes in Materials*¹ for the discipline of Materials Science and Engineering (MSE). The NSP was designed to provide a snapshot of current teaching and learning practice, strongly informed by evidence, across the Materials Science and Engineering discipline. The Materials NSP gathered its main data from the Higher Education Institutions (HEIs) that offered undergraduate and taught postgraduate programmes in Materials Science and Engineering as well as gathering data from recent graduates in Materials and Materials-related disciplines, both at undergraduate (UG) and/or at taught postgraduate (PGT) level. The NSP sought to obtain the views of both Materials Academics and Materials graduates on a variety of topics including professional 'workplace skills, attitudes and abilities' that have been identified as important employability skills that can be enhanced during a student's academic studies.

In this era, large numbers of graduates are looking for jobs and employers no longer recruit simply on the basis of degree status. Whilst a degree might be necessary for the job, employers are looking for a range of other attributes when employing a graduate. Studies have shown² that employers want graduates with a range of personal attributes (such as motivation or problem solving) and interactive attributes (such as team working or leadership) and there are enormous variations in emphasis between different employers, which make it impossible to identify a universal set of

workplace skills. However, in many studies, communication skills (both oral and written) emerge as one of the most important, if not *the* most important, quality that employers require of graduates².

The UKCME's Student Employability Profile in Materials, 2004³, lists key competencies, skills and attributes that can be typically developed through the study of MSE and which add to students' employability skills. The skills were compiled using criteria identified within the QAA Materials subject benchmark statements⁴, cross referencing these with the competencies identified by members of the Council for Industry and Higher Education (CIHE)⁵ Employers Forum as being the attributes and qualities that are the key components they have observed in those individuals who can transform organisations and add value early in their careers. Using the Student Employability Profile in Materials as a foundation, a list of 25 'workplace skills, abilities and attitudes' were compiled.

Materials teaching coordinators, or equivalent, at all 19 HEIs which provide Materials programmes were sent a questionnaire which asked them to provide the collective views of all Materials teaching staff at their Institution on how well they thought their current Materials undergraduate programmes equipped students with each of the 'workplace' skills, abilities and attitudes, and how important each of these skills, abilities and attitudes would be to their graduates in their future careers.

In parallel to this, an online survey⁶ was made available from 27th March until 1st September 2007 to gather the views of recent Materials graduates who had taken the first steps on a Materials-related career. Graduates were targeted through the Institute of Materials, Minerals and Mining (IOM³), UKCME and Engineering Subject Centre websites, and through an email to all Materials academics on the UKCME contacts database asking them to forward details of the questionnaire to Materials graduates. Local and national Materials Societies were also informed. Materials graduates were asked to rank how well they thought their Materials undergraduate degree programme had equipped them with each of the workplace skills identified, and were also asked to rank 'how relevant' these workplace skills, abilities and attitudes were to their current career or studies.

Results and Discussion

Of the 19 HEIs who provide undergraduate programmes in Materials, 17 responded to the questionnaire with the views of their academic teaching staff. A total of 188 Materials graduates completed the online survey, of which 128 were 'recent graduates' from undergraduate Materials programmes (which were considered to be those having graduated since 1998) and whose views form the basis of this study.

Of the 128 recent Materials graduates considered in this study, there was a 65:35 male:female ratio. Of the total respondents, 87% were British, 5% from the EU and 8% 'other overseas' students; 89% of respondents were aged 22 to 30. The types of Materials disciplines undertaken at degree level included general Materials Science and Engineering (45%), Materials Science and Engineering 'with management/language /industrial experience' (9%), and the remainder had undertaken a variety of Materials-related degrees, such as Biomaterials or Sports Materials. There were 73% of the recent graduates in full-time employment whilst 27% were engaged in further study.

The recent graduates were asked to judge 'how well' they felt their Materials undergraduate degree programme had equipped them in each of the 'workplace skills' identified in the study. **Table 1** shows the Materials graduates' ranking of the workplace skills, abilities and attitudes, averaged for all 128 respondents. Alongside

this are the academics' views of how well they believe their Institution's Materials degree equips students with the same skills.

The results show that both graduates and academics believe that Materials students are well equipped in their degree studies for report writing, laboratory skills, and written communication. Both also agree that Materials degree programmes do very little to train them in entrepreneurship, ethics, environmental and safety legislation. Although graduates generally concur with academics in terms of the rank ordering (Spearman $R = 0.934$, $p < 0.001$), the average ranking score from graduates is consistently lower (on average a score of 0.5 lower across all 'skills') than that from academics. **Table 2** shows the differences between the views of Materials academics and graduates for each 'skill' and the list has been ranked in order.

The workplace skills that see the greater differences tend in general to be those skills that were judged by both Materials graduates and academics to be least provided by a Materials programme. For these skills, namely entrepreneurship, ethics, environmental and safety legislation and financial planning, academics generally judge that their Materials programmes contain between 'some' and 'a little' of each of these skills, whereas graduates have judged that they studied between 'a little' and 'none at all'. There is a likelihood that awareness may be raised in some of these areas and some initiatives are already underway. For the last 5 years, the Royal Academy of Engineers has provided a series of lectures, delivered by visiting professors at interested universities. One series of lectures has been 'Engineering design for sustainable development', and environmental legislation (EMAS and ISO14000) is contained within this. The 1997 Dearing report⁷ recommended that professional development planning (PDP) should be offered to all students registered on undergraduate and postgraduate (taught and research) programmes at the UK's HEIs. This was implemented in 2005 and so awareness in PDP is also expected to rise. To promote entrepreneurship, the SPEED project⁸ (Student Placements for Entrepreneurs in EDucation) was launched by the University of Wolverhampton. The project, which is funded by the English funding council (HEFCE), aims to support 750 students with funding to set up their own businesses while they are still studying. Eleven other HEIs are also taking part in the project.

The highest difference is seen in 'business awareness', with academics teaching on Materials programmes considering that their programme contains more than 'some' business awareness, but graduates experiencing only 'a little' during their studies. There is also a difference in the level of IT skills learned on a Materials programme with academics judging that Materials programmes provide 'a lot' of IT skills, whereas graduates (with perhaps more awareness of popular technologies) consider that they experienced only 'some' level of IT skills.

The difference in the level of awareness between academics and graduates, regarding the extent to which 'workplace skills' are being developed during a Materials programme is perhaps a reminder to Materials academics to ensure that students fully understand how their programme of study is preparing them for employment within the Materials profession and how 'workplace skills' are being developed during their studies.

<i>How well does an Undergraduate materials degree equip students with the following 'Workplace' skills, abilities and attitudes?</i>			
Recent graduates views ranked in order		Academics views ranked in order	
Report/technical writing	2.5	2.8	IT skills
Laboratory skills	2.4	2.8	Laboratory skills
Written communication	2.3	2.8	Report/technical writing
Problem solving	2.2	2.6	Oral presentation skills
Research methods	2.2	2.6	Research methods
Teamwork	2.2	2.6	Written communication
Oral presentation skills	2.1	2.5	Problem solving
Enthusiasm	2.0	2.5	Teamwork
IT skills	2.0	2.4	Enthusiasm
Initiative	1.9	2.4	Project planning
Project planning	1.9	2.3	Experimental design
Motivation	1.8	2.3	Initiative
Experimental design	1.7	2.2	Business Awareness
Creativity	1.6	2.2	Creativity
Leadership	1.5	2.2	Motivation
Management	1.3	2.0	Personal development planning
Personal development planning	1.3	1.9	Management
Poster design	1.2	1.8	Safety legislation
Business Awareness	1.1	1.7	Leadership
Career planning	1.1	1.7	Career planning
Safety legislation	1.1	1.7	Ethics
Entrepreneurship	0.9	1.6	Poster design
Environmental legislation	0.8	1.6	Entrepreneurship
Ethics	0.8	1.5	Environmental legislation

Financial planning	0.6	1.4	Financial planning
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Table 1 The views of Materials graduates' and academics teaching on Materials programmes as to 'how well' their undergraduate Materials degree equipped them with workplace skills, abilities and attitudes. A ranking of 'a lot' (=3), 'some' (=2), 'a little' (=1) or 'not at all' (=0) was used and was averaged for all respondents.

<i>How well does an UnderGraduate materials degree equip students with the following 'Workplace' skills, abilities and attitudes?</i>			
the difference between the views of materials academics and materials graduates			
Business Awareness	1.0	Project planning	0.5
Ethics	0.8	Initiative	0.5
Financial planning	0.8	Enthusiasm	0.4
IT skills	0.8	Laboratory skills	0.4
Safety legislation	0.7	Poster design	0.4
Environmental legislation	0.7	Motivation	0.3
Entrepreneurship	0.7	Report/technical writing	0.3
Experimental design	0.6	Research methods	0.3
Personal development planning	0.6	Problem solving	0.3
Career planning	0.6	Written communication	0.3
Management	0.6	Teamwork	0.3
Creativity	0.6	Leadership	0.2
Oral presentation skills	0.5		

Table 2 The differences between the views of academics teaching Materials programmes and Materials graduates' as to 'how well' their undergraduate Materials degree equipped them with workplace skills, abilities and attitudes. A ranking of 'a lot' (=3), 'some' (=2), 'a little' (=1) or 'not at all' (=0) was used and was averaged for each group of respondents.

Materials graduates were also asked to rank 'how relevant' these workplace skills, abilities and attitudes were to their current career or studies. **Table 3** shows the average ranking of the skills etc for all recent Materials graduates, alongside the academics' views of how important they perceived them to be for their Materials graduates.

<i>'HOW IMPORTANT/RELEVANT' ARE THESE 'WORKPLACE' SKILLS, ABILITIES AND ATTITUDES TO A MATERIALS GRADUATE AND THEIR FUTURE CAREER?</i>			
Recent graduates views ranked in order		Academics views ranked in order	
Problem solving	2.8	2.9	Laboratory skills
Project planning	2.8	2.9	Problem solving
Report/technical writing	2.8	2.9	Report/technical writing
Written communication	2.8	2.8	Written communication
Enthusiasm	2.7	2.8	IT skills
Motivation	2.7	2.8	Project planning
Initiative	2.7	2.8	Oral presentation skills
Oral presentation skills	2.7	2.8	Teamwork
IT skills	2.6	2.6	Enthusiasm
Teamwork	2.5	2.6	Initiative
Research methods	2.4	2.6	Research methods
Leadership	2.4	2.5	Experimental design
Management	2.3	2.4	Motivation
Career planning	2.3	2.4	Creativity
Creativity	2.2	2.3	Business Awareness
Personal development planning	2.2	2.2	Safety legislation
Business Awareness	2.2	2.1	Management
Experimental design	2.1	2.1	Personal development planning
Laboratory skills	2.1	2.1	Ethics
Safety legislation	1.9	2.1	Leadership
Ethics	1.7	2.0	Career planning
Financial planning	1.7	2.0	Environmental legislation
Environmental legislation	1.5	1.5	Entrepreneurship
Entrepreneurship	1.5	1.5	Financial planning

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Poster design	1.	1.5	Poster design
	4		

Table 3 Materials graduates' view of the relevance of the workplace skills, abilities and attitudes to their career. A ranking of 'Very relevant' (=3), 'Slightly relevant' (=1.5) and 'Irrelevant' (=0) was used. For comparison the ranking provided by academics of their perceived 'importance' of these skills to their graduates is also provided, using a ranking of 'Essential' (=3), 'Desirable' (=2), 'Welcome' (=1) and 'Not important' (=0).

Once again, there is general agreement in the ranking between graduates and academics (Spearman $R = 0.824$, $p < 0.001$), and both provide comparable ranking scores. The skills that graduates said were most important to their careers, such as 'report writing', 'written communication', 'problem solving' and 'project planning' were also those skills that academics teaching on Materials programmes viewed as most important. It is however noted that graduates rate 'motivation', 'enthusiasm' and 'initiative' slightly higher than academics do.

'Laboratory skills' were rated by academics as one of the most important skills for a Materials graduate, although Materials graduates themselves have not found laboratory skills particularly beneficial to their career. 'Entrepreneurship', 'ethics', and 'environmental and safety legislation' were all viewed by recent Materials graduates to have not been particularly relevant to their early careers, and this concurs with the views of most Materials academics.

Table 4 compares both sets of views from Materials graduates (shown in **Tables 1 & 3**) and gives an indication of whether the workplace skills they have acquired during their degree has matched the skills they have found necessary in the early stages of their careers.

Recent graduates views ranked in order			
<i>How well does an UnderGraduate materials degree equip students with the following 'Workplace' skills, abilities and attitudes?</i>		HOW IMPORTANT/RELEVANT ARE THESE 'WORKPLACE' SKILLS, ABILITIES AND ATTITUDES TO A MATERIALS GRADUATE'S FUTURE CAREER	
Report/technical writing	2.5	2.8	Problem solving
Laboratory skills	2.4	2.8	Project planning
Written communication	2.3	2.8	Report/technical writing
Problem solving	2.2	2.8	Written communication
Research methods	2.2	2.7	Enthusiasm
Teamwork	2.2	2.7	Motivation
Oral presentation skills	2.1	2.7	Initiative
Enthusiasm	2.0	2.7	Oral presentation skills
IT skills	2.0	2.6	IT skills
Initiative	1.9	2.5	Teamwork
Project planning	1.9	2.4	Research methods
Motivation	1.8	2.4	Leadership
Experimental design	1.7	2.3	Management
Creativity	1.6	2.3	Career planning
Leadership	1.5	2.2	Creativity
Management	1.3	2.2	Personal development planning
Personal development planning	1.3	2.2	Business Awareness
Poster design	1.2	2.1	Experimental design
Business Awareness	1.1	2.1	Laboratory skills
Career planning	1.1	1.9	Safety legislation
Safety legislation	1.1	1.7	Ethics
Entrepreneurship	0.9	1.7	Financial planning
Environmental legislation	0.8	1.5	Environmental legislation

Ethics	0.8	1.4	Entrepreneurship
Financial planning	0.6	1.4	Poster design

Table 4 A comparison of Materials graduates' views as to 'how well' their undergraduate Materials degree equipped them with workplace skills, abilities and attitudes (A ranking of 'a lot' (=3), 'some' (=2), 'a little' (=1) or 'not at all' (=0) was used and was averaged for all respondents) alongside their view of the relevance of these skills, abilities and attitudes to their early career (A ranking of 'Very relevant' (=3), 'Slightly relevant' (=1.5) and 'Irrelevant' (=0) was used and was averaged for all respondents). (Spearman R = 0.792, $p < 0.001$).

Materials graduates believe that their degree programme has equipped them well with three of the four skills that were judged to be most important to their early careers, namely 'report writing', 'written communication' and 'problem solving'. However, whilst 'project planning' is ranked as one of the most important career-related skills, graduates believe that they have not been equipped quite so well in this area during their studies. With the exception of 'Laboratory skills', graduates again rate all of the 'workplace skills' as more important in their current career than perhaps is experienced during their studies. They agree that their degree had equipped them well in their 'Laboratory skills' although they have not found laboratory skills particularly beneficial to their career.

The NSP in Materials¹ found that Materials undergraduate programmes used quite traditional teaching methods, with 40% of teaching contact time being spent on conventional lecturing, with the remainder fairly evenly divided between tutorials/seminars, laboratory-work supervision and project-work supervision. Only 2% of teaching contact time was spent in facilitating problem-based learning. The NSP found that some Materials departments/schools/faculties were considering expanding their use of problem-based learning in their Materials programmes. More widespread use of problem-based learning may help students to gain more experience in project planning, and may also help develop graduates' 'motivation', 'enthusiasm' and 'initiative'.

Conclusions

As part of a National Subject Profile study undertaken for the Materials discipline, the views of staff teaching Materials, and recent Materials graduates, have been obtained in relation to the professional 'workplace skills, attitudes and abilities' that Materials students acquire during their academic studies, and whether they match the skills, attitudes and abilities that graduates require in the early stages of their professional careers. Both graduates and academics believe that Materials students are well equipped in their degree studies for report writing, laboratory skills, and written communication. Both also agree that Materials degree programmes do very little to train them in entrepreneurship, ethics, environmental and safety legislation, although the various new initiatives recently launched, are likely to promote these skills, particularly in the areas of entrepreneurship, environmental legislation and PDP.

In general, Materials academics believe that their programmes offer more opportunities for workplace skills development than the Materials graduates recognised. There may be several reasons for this given that the views are subjective, and that some of the graduates surveyed will have graduated up to ten years ago when there may have been less of an emphasis on employability skills. However, the findings should act as a reminder to the Materials academic community to ensure that students fully understand how their programme of study is preparing

them for employment within the Materials profession and how 'workplace skills' are being continually developed during their studies.

The skills that graduates said were most important to their careers, such as 'report writing', 'written communication', 'problem solving' and 'project planning' were also those skills that academics teaching on Materials programmes viewed as most important. 'Laboratory skills' were rated by academics as one of the most important skills for a Materials graduate, although Materials graduates themselves have not found laboratory skills particularly beneficial to their career.

Materials graduates believe that their degree programme has equipped them well with three of the four skills that were judged to be most important to their early careers, namely 'report writing', 'written communication' and 'problem solving'. However, whilst 'project planning' is ranked as one of the most important career-related skills, graduates believe that they have not been equipped quite so well in this area during their studies. However, as the use of problem-based learning techniques is expected to increase, this may help students to gain more experience in project planning, and may also help develop graduates' 'motivation', 'enthusiasm' and 'initiative'. With the exception of 'Laboratory skills', graduates rate all of the 'workplace skills' as more important in their current career than is experienced during their studies.

References

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³ UKCME's Student Employability Guide, 2004, at <http://www.materials.ac.uk/employability/profile.asp>

⁴ QAA Subject Benchmark Statements at <http://www.qaa.ac.uk/academicinfrastructure/benchmark/default.asp>

⁵ *Graduates Work* by Professor Lee Harvey, CIHE 2001

⁶ NSP Online survey available at <http://www.materials.ac.uk/subject-profile/report.asp>

⁷ DEARING, R. (1997) *Report of the National Committee of Inquiry into Higher Education* at <http://www.leeds.ac.uk/educol/ncihe/>

⁸ SPEED project at http://www.hero.ac.uk/uk/business/archives/2007/entrepreneurs_speed_ahead_Apr.cfm

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